

6. (Amended) The semiconductor device according to claim 5, wherein said cell plate electrode further includes a tantalum nitride film formed between said second indium oxide film and said copper film, contacting both said second indium oxide film and said copper film.

REMARKS

At the time of the Office Action dated August 29, 2001, claims 1-6 were pending and rejected in this application. Claims 2-6 have been amended, and Applicants submit that the present Amendment does not generate any new matter issue.

On page two of the Office Action, the Examiner objected to the Specification. In particular, the Examiner states that the "well-known value" of the work function for TaN is 2.17 eV, whereas the values of the work functions for  $TaN_x$  stated in the specification are 5.41 eV and 5.95 eV. As such, the Examiner asserts that the value of  $x$  in  $TaN_x$  must significantly deviate from 1.

In response, Applicants respectfully submit that the Examiner's assertion as to the value of the work functions is inaccurate. As discussed in U.S. Patent No. 6,130,123 to Liang, et al. (reproduced in part below), a reported value for the work function of TaN is 5.41 eV.

U.S. Patent No. 6,130,123 to Liang, et al.:

In a P-type doped silicon, the Fermi level is closer to the valence band than the conduction band (e.g., about 5.2 electron-volts).

Metals or their compounds have been identified that have work functions similar to the work functions of a conventional P-type doped semiconductor substrate ... Examples of metals that have a work function similar to P-type doped semiconductor material, include ... tantalum nitride (TaN).

As shown in FIG. 4, substrate 100 is then exposed to an ambient such as ammonia ( $NH_3$ ) or nitrogen ( $N_2$ ). The reactive ambient interacts with the exposed areas of metal layer 130 overlying N-type well 115. In the case of a tantalum metal layer, the interaction and reaction between tantalum and  $NH_3$  or  $N_2$  produces a metal layer of tantalum nitride (TaN) over N-type well 115. A TaN metal layer has a reported work function of 5.41 electron volts, suitable for use as a P-type gate electrode. (emphasis added)

Applicants, therefore, respectfully suggest that the values of the work functions stated in the Specification are consistent with reported values; and thus, no further elaboration as to the value of x is necessary.

On pages two and three of the Office Action, the Examiner also objected to the term "said indium oxide film," which is found in claims 4-6. The Examiner states that this term is ambiguous because claim 3, upon which claims 4-6 depend, refers to two different indium oxide films. By this Amendment, claims 3-6 have been amended to include references to both a "first" indium oxide film and a "second" indium oxide film, as appropriate. By this Amendment, the Examiner's objection as to claims 4-6 have been traversed.

**Claim 3 is rejected under 35 U.S.C. § 102(b) for lack of novelty as evidenced by Izumi et al., U.S. Patent No. 5,644,151 (hereinafter Izumi)**

In the first enumerated paragraph of the Office Action, the Examiner referred particularly to Fig. 1, asserting the disclosure of a semiconductor device corresponding to that claimed. This rejection is respectfully but vigorously traversed.

Applicants submit that the Examiner did not establish a prima facie basis to deny patentability to the claimed invention under 35 U.S.C. § 102 for lack of the requisite factual basis. In this respect, Applicants would stress that the factual determination of lack of novelty under 35 U.S.C. § 102 requires the identical disclosure in a single reference of each element of a claimed invention, such that one having ordinary skill in the art would have recognized that the identically claimed invention is within the public domain. **ATD Corporation v. Lydall, Inc.**, 159 F.3d 534, 48 USPQ2d 1321 (Fed. Cir. 1998); **Electro Medical Systems S.A. v. Cooper Life Sciences, Inc.**, 34 F.3d 1048, 32 USPQ2d 1017 (Fed. Cir. 1994). Furthermore, a prior art

references which contains a broad disclosure requiring guessing, testing, speculation or "picking and choosing" from a broad disclosure does not constitute an identical description of a claimed invention within the meaning of 35 U.S.C. § 102. **Minnesota Mining & Manufacturing Co. v. Johnson & Johnson Orthopaedics Inc.**, 976 F.2d 1559, 24 USPQ2d 1321 (Fed. Cir. 1992); **Air Products & Chemicals, Inc. v. Charles S. Tanner Co.**, 219 USPQ 223 (D.S.C. 1983).; **In re Arkley**, 455 F.2d 586, 172 USPQ 524 (CCPA 1972). The broad disclosure of Izumi in column 6, lines 34-50 regarding all the possible materials that can be used to form the cell plate electrodes and capacitor dielectric film would require guessing, testing, and/or speculation to arrive at the claimed invention. As such, Applicants respectfully submit that a *prima facie* basis to deny patentability has not been established.

Moreover, there are significant fundamental differences between the claimed semiconductor device and the device of Izumi that preclude the factual determination that Izumi identically describes the claimed invention within the meaning of 35 U.S.C. § 102. Claim 3, as amended, now recites "a contact plug including tungsten formed on the semiconductor substrate." In contrast, Izumi teaches that the lower electrode 7 is formed on a diffused region 2. As such, Izumi fails to teach all the features of the claimed invention.

The Examiner is also referred to lines 17-27 on page four of the specification, reproduced below.

In such a structure, the storage electrode and the cell plate electrode are formed of indium oxide film, which minimizes the likelihood of a reductive elimination reaction of the tantalum oxide film forming the capacitor dielectric film occurring during the manufacturing process. Accordingly, possibility of elimination of oxygen atoms within the tantalum oxide film due to the reductive reaction is reduced. Thus, a high degree of crystallinity is kept for the tantalum oxide film constituting the capacitor dielectric film. This restricts generation of a leakage current in the capacitor dielectric film due to the deficiency of the oxygen atoms within the tantalum oxide film. As a result, it is possible to increase the charge retaining capability of the capacitor.

As such, the claimed structure produces unexpected benefits that are not recognized by the applied prior art.

The above argued difference between the claimed invention and the semiconductor device of Izumi undermines the factual determination that Izumi identically describes the claimed invention within the meaning of 35 U.S.C. § 102. **Kloster Speedsteel AB v. Crucible Inc.**, 793 F.2d 1565, 230 USPQ 81 (Fed. Cir. 1986). Applicants, therefore, respectfully submit that the imposed rejection of claim 3 under 35 U.S.C. § 102 for lack of novelty as evidenced by Izumi is factually erroneous and, hence, solicit withdrawal thereof.

**Claim 4 is rejected under 35 U.S.C. § 102(b) for lack of novelty as evidenced by Nishioka et al., U.S. Patent No. 5,811,851 (hereinafter Nishioka)**

In the second enumerated paragraph of the Office Action, the Examiner referred particularly to Fig. 8 and the table in column 7, asserting the disclosure of a semiconductor device corresponding to that claimed. This rejection is respectfully but vigorously traversed.

As previously pointed out, the factual determination of lack of novelty under 35 U.S.C. § 102 requires the identical disclosure in a single reference of each element of a claimed invention such that one having ordinary skill in the art would have recognized that the identically claimed invention is within the public domain. **ATD, Corp. v. Lydall, Inc.**, supra; **Electro Medical Systems S.A. v. Cooper Life Sciences, Inc.**, supra. The Examiner has referred to the Table in columns 7 and 8 of Nishioka as disclosing the materials of the claimed invention. As with Izumi, Nishioka is a broad disclosure that requires guessing, testing, speculation or "picking and choosing" to arrive at the claimed invention. Furthermore, notwithstanding the extensive list of

possible materials listed by Nishioka for the conductive plug 34, Nishioka failed to disclose a conductive plug or storage electrode that includes a tantalum nitride film.

Applicants also note that the Examiner is using the disclosure of "an oxide" for the upper electrode 44 of Nishioka to support the disclosure of the recited upper electrode formed of indium oxide recited. In this regard, the Examiner is reminded that, in rejecting a claim under 35 U.S.C. § 102, it is incumbent upon the Examiner to identify wherein an applied reference identically discloses each feature of the claimed invention. **In re Rijckaert**, 9 F.3d 1531, 28 USPQ2d 1955 (Fed. Cir. 1993); **Lindermann Maschinenfabrik GMBH v. American Hoist & Derrick Co.**, 730 F.2d 1452, 221 USPQ 481 (Fed. Cir. 1984). The disclosure of "an oxide" does not identically disclose indium oxide. Accordingly, the imposed rejection under 35 U.S.C. § 102 is inappropriate.

The above argued difference between the claimed invention and the semiconductor device of Nishioka undermines the factual determination that Izumi identically describes the claimed invention within the meaning of 35 U.S.C. § 102. Applicants, therefore, respectfully submit that the imposed rejection of claim 4 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nishioka is factually erroneous and, hence, solicit withdrawal thereof.

**Claim1 is rejected under 35 U.S.C. § 103 for obviousness predicated upon Alers, et al., U.S. Patent No. 6,265,260 B1 (hereinafter Alers 1), in view of a publication to Drynan, et al. (hereinafter Drynan)**

On page five of the Office Action, the Examiner concluded that the combined disclosures of Alers 1 and Drynan generated the invention as claimed. This rejection is respectfully traversed.

In rejecting a claim under 35 U.S.C. § 103, the Examiner is required to identify a source in the applied prior art for claim limitations and a source for the requisite motivation to combine references or modify a reference in a specific manner to arrive at a specifically claimed invention. **Smiths Industries Medical System v. Vital Signs Inc.**, 183 F.3d 1347, 51 USPQ2d 1415 (Fed. Cir. 1999). The requisite motivation to support the ultimate legal conclusion of obviousness under 35 U.S.C. § 103 is not an abstract concept, but must stem from the applied prior art as a whole and have realistically impelled one having ordinary skill in the art to combine specific references to arrive at a specifically claimed invention. **In re Deuel**, 51 F.3d 1552, 34 USPQ2d 1210 (Fed. Cir. 1995); **In re Newell**, 891 F.2d 899, 13 USPQ2d 1248 (Fed. Cir. 1989). The mere identification of claim features in disparate references does not establish the requisite realistic motivation to support the ultimate legal conclusion of obviousness under 35 U.S.C. § 103. **Grain Processing Corp. v. American-Maize Products Co.**, 840 F.2d 902, 5 USPQ2d 1788 (Fed. Cir. 1988). Moreover, a generalization does not establish the requisite motivation to modify a specific reference in a specific manner to arrive at a specifically claimed invention. **In re Deuel, *supra***. Rather, a burden is imposed upon the Examiner to identify a source in the applied prior art for each claim limitations and identify a source for the requisite realistic motivation to modify a particular reference in a particular manner to arrive at a specifically claimed invention. **Smiths Industries Medical System v. Vital Signs Inc.**, 183 F.3d 1347, 51 USPQ2d 1415 (Fed. Cir. 1999); **In re Mayne, *supra***.

The Examiner has stated that one having ordinary skill in the art would be motivated to combine Drynan with Alers 1. However, Drynan teaches away from the claimed invention by teaching that not only the contact plug be formed from tungsten, but also the top and bottom electrodes. The purpose stated by Drynan for creating a bilayer (W/W) structure is reduced

resistance. In contrast, claim 1 recites "a tantalum nitride film formed on and contacting an upper surface of said tungsten film." As such, one having ordinary skill in the art at the time of the invention following the teachings of Drynan would not have been motivated to combine Alers and Drynan to arrive at the claimed invention.

Based upon the arguments submitted supra, it should be apparent that a prima facie basis to deny patentability to the claimed invention has not been established for lack of the requisite realistic motivation. Moreover, there are potent indicia of nonobviousness of record which undermine the PTO's obviousness conclusion.

Specifically, as previously pointed out, Drynan teaches away from the claimed invention, and this teaching away from the claimed invention constitutes an indicium of nonobviousness. **In re Bell**, 991 F.2d 781, 26 USPQ2d 1529 (Fed. Cir. 1993); **Specialty Composites v. Cabot Corp.**, 845 F.2d 981, 6 USPQ2d 1601 (Fed. Cir. 1988); **In re Hedges**, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986); **In re Marshall**, 578 F.2d 301, 198 USPQ 344 (CCPA 1978).

Furthermore,

Moreover, the Examiner is also referred to first three full paragraphs on page three of the specification, reproduced below.

In such a structure, the storage electrode and the cell plate electrode are formed of tantalum nitride film, the work function of which is greater than that of the titanium nitride film used to form the cell plate electrode of the capacitor in the conventional semiconductor device. This restricts introduction of electrons into the tantalum oxide film forming the capacitor dielectric film. Thus, it is possible to suppress generation of a leakage current in the capacitor dielectric film.

Further, the contact plug is formed using the tungsten film. Therefore, it is possible to prevent oxidation of the upper surface of the contact plug, which would be inevitable during a manufacturing process when a polysilicon film is used to form the storage electrode as in the case of the conventional semiconductor device. This prevents formation of additional capacitance because of the oxidation of the upper surface of the contact plug. As a result, reduction of capacitance of the capacitor is suppressed.

Moreover, the tantalum nitride film offering an effective barrier is formed on the tungsten film. Thus, counter diffusion between the tungsten film and the tantalum nitride film is prevented. This restricts generation of a leakage current in the capacitor dielectric film due to the counter diffusion between the contact plug and the storage electrode. As a result, the charge retaining capability of the capacitor is improved.

As such, the claimed structure produces unexpected benefits that are not recognized by the applied prior art, and these unexpected benefits constitute indicia on nonobviousness.

It should, therefore, be apparent that the PTO did not discharge the initial burden of establishing a prima facie case of obviousness under 35 U.S.C. § 103. Moreover, upon giving due consideration to the nonobviousness indicia of record stemming from the apparent incompatibility of Alers 1 and the prior art and the unexpected benefits provided by the present invention, the conclusion appears inescapable that one having ordinary skill in the art would not have found the claimed invention as a whole obvious within the meaning of 35 U.S.C. § 103. **In re Piasecki**, 745 F.2d 1468, 223 USPQ 785 (Fed. Cir. 1984); **Jones v. Hardy**, 727 F.2d 1524, 220 USPQ 1021 (Fed. Cir. 1984). Applicants, therefore, respectfully submit that the imposed rejection of claim 1 under 35 U.S.C. § 103 for obviousness predicated upon Alers 1 in view of Drynan is not factually or legally viable and, hence, solicit withdrawal thereof.

**Claim 2 is rejected under 35 U.S.C. § 103 for obviousness predicated upon Alers 1 in view of Alers, U.S. Patent No. 6,271,596 B1 (hereinafter Alers 2)**

On page seven of the Office Action, the Examiner asserted that Alers 1 teaches all of the claimed limitations except a copper film formed on an upper surface of a tantalum nitride film, which is taught by Alers 2. This rejection is respectfully traversed.

Applicants respectfully submit that the Examiner has failed to establish that the combination of Alers 1 and Alers 2 would generate the claimed invention. Claim 2 recites that a copper film is formed on an upper surface of a tantalum nitride film. However, Alers 1 teaches that the plug 35 is formed from tungsten. Although the Examiner asserted Alers 2 teaches that the film formed on the top electrode can be copper, this assertion is false. The column and line

referred to by the Examiner in Alers 2 only teaches that the bottom electrode 301 can be formed from copper. Furthermore, Alers 2 does not discuss at all any structure or material formed above the upper electrode 303. As such, Alers 2 cannot teach a copper film formed on an upper surface of a tantalum nitride film. Thus, even if Alers 1 and Alers 2 were combined, the claimed invention would not result.

**Claims 5 and 6 are rejected under 35 U.S.C. § 103 for obviousness predicated upon**

**Nishioka in view Alers 2**

On page eight of the Office Action, the Examiner concluded that the combination of Nishioka in view Alers 2 disclosed the invention as claimed. This rejection is respectfully traversed.

Claims 5 and 6 depend ultimately from independent claim 3, and Applicants incorporate herein the arguments previously advanced in traversing the imposed rejection of claim 3 under 35 U.S.C. § 102 for lack of novelty as evidenced by Nishioka. Specifically, Nishioka is a broad disclosure that requires "picking and choosing" to arrive at the claim invention and Nishioka fails to disclose a conductive plug or storage electrode that includes a tantalum nitride film or a indium oxide upper electrode. The secondary reference to Alers 2 does not cure the argued deficiencies of Nishioka. Accordingly, even if Nishioka and Alers 2 were combined, the proposed combination of references would not yield the claimed invention. **Uniroyal, Inc. v. Rudkin-Wiley Corp.**, 837 F.2d 1044, 5 USPQ2d 1434 (Fed. Cir. 1988). Applicant, therefore, respectfully submits that the imposed rejection of claims 5 and 6 under 35 U.S.C. § 103 for obviousness predicated upon Nishioka in view Alers 2 is not factually or legally viable and, hence, solicits withdrawal thereof.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

Applicants have made every effort to present claims which distinguish over the prior art, and it is believed that all claims are in condition for allowance. However, Applicants invite the Examiner to call the undersigned if it is believed that a telephonic interview would expedite the prosecution of the application to an allowance. Accordingly, and in view of the foregoing remarks, Applicants hereby respectfully request reconsideration and prompt allowance of the pending claims.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417, and please credit any excess fees to such deposit account.

Respectfully submitted,

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**Version with markings to show changes made**

**IN THE CLAIMS:**

Please amend claims 2-6 as follows:

2. (Amended) A semiconductor device, comprising:

a storage electrode including a tantalum nitride film formed [on] over a semiconductor substrate;

a capacitor dielectric film including a tantalum oxide film formed on and contacting an upper surface of said tantalum nitride film; and

a cell plate electrode including a tantalum nitride film formed on and contacting an upper surface of said tantalum oxide film and a copper film formed on and contacting an upper surface of said tantalum nitride film.

3. (Amended) A semiconductor device, comprising:

a semiconductor substrate;

a contact plug including tungsten formed on the semiconductor substrate;

a storage electrode including a first indium oxide film formed on and contacting an upper surface of said contact plug [a semiconductor substrate];

a capacitor dielectric film including a tantalum oxide film formed on and contacting an upper surface of said first indium oxide film; and

a cell plate electrode including a second indium oxide film formed on and contacting an upper surface of said tantalum oxide film.

4. (Amended) The semiconductor device according to claim 3, wherein said storage electrode further includes a tantalum nitride film formed beneath and contacting a lower surface of said first indium oxide film.

5. (Amended) The semiconductor device according to claim 3, wherein said cell plate electrode further includes a copper film formed on said second indium oxide film.

6. (Amended) The semiconductor device according to claim 5, wherein said cell plate electrode further includes a tantalum nitride film formed between said second indium oxide film and said copper film, contacting both said second indium oxide film and said copper film.